# ANSWERS: Solubility constant

**FeS**

$K_s(FeS) = 4.90 \times 10^{-18}$

$FeS \rightleftharpoons Fe^{2+} + S^{2-}$

$Ks = [Fe^{2+}]\,[S^{2-}]$

$Ks = [s]\,[s]$

$4.90 \times 10^{-18} = s \text{ times } s$

$4.90 \times 10^{-18} = s^2$

$\sqrt{4.90 \times 10^{-18}} = s$

$2.21359 \times 10^{-9} = s$

Answer: $2.21 \times 10^{-9}$ mol $L^{-1}$

**$Fe(OH)_2$**

$Ks = 4.10 \times 10^{-15}$

$Fe(OH)_2(s) \rightleftharpoons Fe^{2+}(aq) + 2OH^-(aq)$

$Ks = [Fe^{2+}]\,[OH^-]^2$

$[Fe^{2+}] = s$

$[OH^-] = 2s$

$Ks = s \times (2s)^2$

$4.10 \times 10^{-15} = 4s^3$

$s = 1.01 \times 10^{-5}$ mol $L^{-1}$

Answer = $1.01 \times 10^{-5}$ mol $L^{-1}$

**$Zn(OH)_2$**

$Ks = 3.00 \times 10^{-17}$

$Zn(OH)_2(s) \rightleftharpoons Zn^{2+}(aq) + 2OH^-(aq)$

$Ks = [Zn^{2+}][OH^-]^2$

Let $s$ be solubility

$K_s = 4s^3$

$s = \sqrt[3]{\frac{K_s}{4}}$

$s = 1.96 \times 10^{-6}$ mol $L^{-1}$

**$Ag_2CrO_4$**

$Ks(Ag_2CrO_4) = 3.00 \times 10^{-12}$

$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$

$K_s = [Ag^+]^2[CrO_4^{2-}]$

$K_s = (2s)^2(s) = 4s^3$

$s = \sqrt[3]{\frac{K_s}{4}}$

$s = 9.09 \times 10^{-5}$ mol $L^{-1}$

**AgCl**

$Ks\ (AgCl) = 1.56 \times 10^{-10}$

$AgCl \rightleftharpoons Ag+(aq) + Cl-(aq)$

$K_s = [Ag^+][Cl^-]$

$= 1.56 \times 10^{-10} = s^2$

$s = 1.25 \times 10^{-5}$

$[Ag^+] = 1.25 \times 10^{-5}$ (mol $L^{-1}$)

**$PbCl_2$**

$Ks(PbCl_2) = 1.60 \times 10^{-5}$

$PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$

$K_s(PbCl_2) = [Pb^{2+}]\,[Cl^-]^2$

$K_s = s\,(2s)^2$

$1.60 \times 10^{-5} = 4s^3$

$s = 0.0159$ mol $L^{-1}$

solubility of $PbCl_2(s) = 0.0159$ mol $L^{-1}$

**$Mg(OH)_2$**

$K_s(Mg(OH)_2) = 1.25 \times 10^{-11}$

$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$

$K_s = 4s^3 = 1.25 \times 10^{-11}$

$s^3 = 3.125 \times 10^{-12}$

$s = 1.46 \times 10^{-4}$

solubility is $1.46 \times 10^{-4}$ mol $L^{-1}$

**$CaSO_4$**

$K_s\ (CaSO_4) = 2.45 \times 10^{-5}$

$CaSO_4(s) \rightleftharpoons Ca^{2+}(aq) + SO_4^{2-}(aq)$

Reverse eqn also acceptable.

*Subscripts not required but penalise $CaSO_4(aq)$.*

$K_s\ (CaSO_4) = [Ca^{2+}][SO_4^{2-}] = 2.45 \times 10^{-5}$

$S = \sqrt{(2.45 \times 10^{-5})} = 4.95 \times 10^{-3}$ mol $L^{-1}$

**$PbF_2$**

$K_s = 3.7 \times 10^{-8}$

$PbF_2\ (s) \rightleftharpoons Pb^{2+}\ (aq) + 2F^-\ (aq)$

$K_s = [Pb^{2+}][F^-]^2$

$[Pb^{2+}] = s$ then $K_s = 4s^3$

$s = \frac{1}{4}(3.7 \times 10^{-8}$

**s** = $2.10 \times 10^{-3}$ mol $L^{-1}$ = $[Pb^{2+}]$

**1)** $K_s = [Ag^+]^2[CrO_4^{2-}]$

$$n(Ag_2CrO_4) = \frac{1.44 \times 10^{-3}}{332}$$

$$= 4.33 \times 10^{-6} \text{ mol in 50 mL}$$

$$[Ag_2CrO_4] = \frac{4.33 \times 10^{-6}}{50 \times 10^{-3}}$$

$$= 8.67 \times 10^{-5} \text{ mol L}^{-1}$$

$$[Ag^+] = 8.67 \times 10^{-5} \times 2 = 1.73 \times 10^{-4} \text{ mol L}^{-1}$$

$$[CrO_4^{2-}] = 8.67 \times 10^{-5} \text{ mol L}^{-1}$$

$$K_s = (1.73 \times 10^{-4})^2 (8.67 \times 10^{-5})$$

$$= 2.61 \times 10^{-12}$$

**2)** $FeS \rightleftarrows Fe^{2+} + S^{2-}$

$K_s = [Fe^{2+}][S^{2-}]$

Let solubility = $s$

$K_s = s^2$

$4.9 \times 10^{-18} = s^2$

$s = \sqrt{4.9 \times 10^{-18}}$

$= 2.21 \times 10^{-9} \text{ mol L}^{-1}$

**3)** $K_s = [Ag^+][Cl^-]$

$1.56 \times 10^{-10} = [0.100][Cl^-]$

$[Cl^-] = 1.56 \times 10^{-9}$

$n = c \times V$

$= 1.56 \times 10^{-9} \times 5.00 \text{ mol}$

$= 7.80 \times 10^{-9} \text{ mol}$

$m = n \times M$

$= 7.80 \times 10^{-9} \text{ mol} \times 58.5 \text{ g mol}^{-1}$

$= 4.56 \times 10^{-7} \text{ g}$

**4) a)** Solubility is the amount of substance that will dissolve in a given volume to form a saturated solution (at that temperature).

**b)** *K*s is an equilibrium constant for the reaction

$AgCl(s) \rightleftarrows Ag+ (aq) + Cl– (aq)$ and *K*s = [Ag+][Cl–]

More solid dissolves when the temperature is increased as equilibrium shifts in the endothermic direction, which means it shifts to the right and increases the concentration of ions in solution. This increases *K*s.

**c)**

(i) $[Ag^+] = [Cl^-] = solubility, s$

$K_s = s^2$ so $s = \sqrt{K_s} = 1.25 \times 10^{-5} \text{ mol L}^-$

(ii) $K_s = [Ag^+]^2[CrO_4^{2-}]$ so $s = \sqrt[3]{\frac{K_s}{4}}$

$= 6.88 \times 10^{-5} \text{ mol L}^{-1}$

$K_s(Ag_2CrO_4) = [Ag^+]^2 [CrO_4^{2-}]$

$= 1.30 \times 10^{-12}$

**d)** $[Ag^+]^2 = \frac{1.3 \times 10^{-12}}{6.3 \times 10^{-3}} = 2.06 \times 10^{-10}$

$[Ag^+] = 1.44 \times 10^{-5} \text{ mol L}^{-1}$